

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A low-frequency vibration control system, comprising:

an electromagnetic actuator for selectively applying forces to a controlled structure at a first region of said controlled structure, said forces being adapted to interfere with corresponding forces received at a second region of said controlled structure so that substantial vibration cancellation occurs at a third region of said controlled structure, said actuator consisting essentially of an armature, a magnet coil and a flux sensor; and

a digital control system for causing a force-linearized flux to be generated in a gap between said armature and said magnetic coil, as a function of sensed vibration, said control system comprising logic for defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship; and

wherein said flux sensor sends signals to said digital control system representative of the flux generated in said gap between said armature and said magnetic coil.

2. (Original) The vibration control system of claim 1, wherein said magnet coil is integrally fixed to said controlled structure.

3. (Original) The vibration control system of claim 2, wherein said flux sensor is connected to said magnet coil.

4. (Currently amended) A vibration control system for a variable-state structure, said system comprising:

electromagnetic actuators for selectively applying forces to said variable-state structure at a first coupling point of said variable-state structure, wherein at least one of said actuators includes an armature, a magnetic coil, a gap located between said armature and said magnetic coil, and a flux sensor located in said gap, and wherein said magnetic coil is arranged to apply an attractive magnetic force to said armature across said gap; and

a digital control system for producing a force-linearized flux in said gap, and for operating said actuators as a function of sensed vibration of said variable-state structure, said sensed vibration of said variable-state structure being received at a second coupling point of said variable-state structure, sensed vibration of a feedforward reference, and the variable state of said variable-state structure, said digital control system comprising logic for defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship;

wherein said sensed vibration of said variable-state structure is substantially canceled.

5. (Original) The vibration control system of claim 4, further comprising vibration sensors for sensing the vibration of said variable-state structure.

6. (Original) The vibration control system of claim 5, wherein said digital control system includes modal feedback loops for controlling said actuators in response to signals from said vibration sensors.

7. (Original) The vibration control system of claim 6, wherein the gains of said modal feedback loops are controlled as a function of the variable state of said variable-state structure.

8. (Original) The vibration control system of claim 4, further comprising one or more feedforward sensors for sensing vibration of feedforward references.

9. (Original) The vibration control system of claim 8, wherein said digital control system includes one or more feedforward loops for controlling said actuators in response to signals from said feedforward sensors.

10. (Original) The vibration control system of claim 9, wherein the plant transfer functions of said feedforward loops are controlled as a function of the variable state of said variable-state structure.

11. (Original) The vibration control system of claim 10, further comprising a position sensor for sensing a variable position of said variable-state structure.

12. (Original) The vibration control system of claim 10, further comprising a device for inputting data representative of the mass of said variable-state structure.

13. (Currently amended) A method of controlling vibration of a variable-state structure, said method comprising the steps of:

obtaining first data representative of the vibration of said variable-state structure;

obtaining second data representative of variable mechanical characteristics of said variable-state structure;

defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship;

selectively applying force-linearized magnetic flux to produce electromagnetic forces on said variable-state structure at a first coupling of said variable-state structure

as a function of said first data and said second data, wherein said vibration is driven at a second coupling of said variable-state structure; and

attenuating the vibration of in a region of said variable-state structure.

14. (Original) The method of claim 13, further comprising the step of operating a feedforward loop based on a fixed-frequency reference that is external to said variable-state structure.

15. (Original) The method of claim 14, further comprising the step of changing the plant transfer function estimates of said feedforward loop as a function of said second data.

16. (Original) The method of claim 15, further comprising the step of changing the characteristics of said feedforward loop as a function of said first data.

17. (Original) The method of claim 16, further comprising the step of operating modal feedback loops based on said first data.

18. (Original) The method of claim 17, further comprising the step of changing the gain of said feedback loops as a function of said first data.

19. (Currently amended) A vibration control system, comprising:

an actuator for applying a force to a variable-state structure at a first coupling location of said variable-state structure, said actuator including an electromagnet, an armature and a magnetic flux density sensor, and wherein said magnetic flux density sensor is operatively located so as to sense the magnetic flux between said electromagnet and said armature;

a data input device for inputting data representative of the variable state of said variable-state structure including data related to a force received at a second coupling location of said variable-state structure; and

a processor for applying force-linearized magnetic flux producing signals to said electromagnet for canceling unwanted vibration in a region of said variable-state structure, said processor being operatively connected to said data input device and said magnetic flux density sensor, said processor defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship.

20. (Original) The vibration control system of claim 19, wherein said processor is arranged to calculate the difference between the flux density sensed by the magnetic flux density sensor and the flux density required in the actuator to control vibration of the variable-state structure.

21. (Original) The vibration control system of claim 20, wherein said electromagnet is integrally connected to said variable-state structure, and said armature is integrally connected to an external structure.

22. (Original) The vibration control system of claim 21, wherein said electromagnet is sealed to prevent degradation by fluids and dust.

23. (Currently amended) A vibration control system for a variable-state structure, said system comprising:

electromagnetic actuators for selectively applying forces to said variable-state structure at a first coupling point of said variable-state structure, said forces being adapted to cancel the effects of corresponding forces received at a second coupling point of said variable-state structure, wherein at least one of said actuators includes an armature, a magnetic coil, a gap located between said armature and said magnetic coil,

and a flux sensor located in said gap, and wherein said magnetic coil is arranged to apply an attractive magnetic force to said armature across said gap; and

a digital control system for operating said actuators as a function of sensed vibration of said variable-state structure, sensed vibration of a feedforward reference, and the variable state of said variable-state structure, said sensed vibration of said variable-state structure being received at the second coupling point of said variable-state structure, said control system comprising logic for defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship.

Claim 24 (canceled).

25. (Currently amended) A vibration control system, comprising:

an actuator for applying a force to a variable-state structure at a first coupling location of said variable-state structure, said forces being adapted to cancel the effects of corresponding forces received at a second coupling location of said variable-state structure, said actuator including an electromagnet, an armature and a magnetic flux density sensor, and wherein said magnetic flux density sensor is operatively located so as to sense the magnetic flux between said electromagnet and said armature;

a data input device for inputting data representative of the variable state of said variable-state structure including data related to a force received at the second coupling location of said variable-state structure; and

a processor for applying signals to said electromagnet, said processor being operatively connected to said data input device and said magnetic flux density sensor, said processor defining a non-linear value of flux demand so as to yield an accurate linear control-demand-to-output-force relationship.

26. (Previously Presented) A method of controlling vibration in a structure comprising:

receiving a first mechanical vibration signal from an electromagnetic actuator at a first coupling point of said structure, said electromagnetic actuator including an armature, a magnetic coil, a gap located between said armature and said magnetic coil, and a flux sensor located in said gap;

receiving a second mechanical vibration signal at a second coupling point of said structure; and

receiving, at a defined region of said structure, a third mechanical vibration signal, said third mechanical vibration signal including a portion of said second mechanical vibration signal attenuated by a portion of said first mechanical vibration signal.